Ocean & Coastal Management 119 (2016) 76–92

Contents lists available at ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

# Options for socioeconomic developments in ICZM for the tri-national Wadden area☆

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ARTICLE INFO

*Article history:*
Received 21 January 2014
Received in revised form
23 September 2015
Accepted 9 October 2015
Available online 22 October 2015

*Keywords:*
Wadden area
Combined ecological and socio-economic (valuation) system
Population by age
Employment
Unemployment

ABSTRACT

The Wadden Sea Forum has adopted integrated coastal zone management (ICZM) as a process for achieving the sustainable development of the Wadden Sea in a way that is environmentally sound, economically viable and socially beneficial. This requires, besides information about the ecosystem, also information and analysis of recent demographic and socioeconomic developments in the entire trilateral (with parts in the Netherlands, Germany and Denmark) Wadden region at the very detailed spatial scale of municipalities bordering the Wadden Sea. We find that the area suffers from population decline and an ageing population due to selective migration processes. As a result, the potential labour force is declining. The number of jobs in the Wadden region is also declining and unemployment is relatively high. The regional economic structure of the trilateral Wadden area is very diverse and differs substantially from the national economic structure. However, even within the Wadden area, there are substantial economic differences over space between the islands and the coast, but also between neighbouring municipalities within the coastal areas. For a vital regional economy, any economic development should be targeted at activities that do not have a negative effect on the ecosystem and that can be employed at an economic and spatial scale that fits the natural environment and matches the type of skills and jobs of the inhabitants. Our analysis shows that within sectors such as agriculture, fishing, tourism and personal and business services there are many types of activities that fit within these limitations that could be used to foster a vital regional economy in the Wadden region. Further, jobs can be created further away from the coastal zone as long as these jobs are created in urban areas within a reasonable commuting distance. Large-scale industrial activities in the Wadden area should be discouraged and, if necessary, only be allowed in the present industrial zones provided any potential damage to the ecosystem can be avoided. Given these pressures and management challenges, if ICZM in the broader sense is to be achieved, insights are needed into the combined ecological and socioeconomic (valuation) system of the whole Wadden Sea area in order to design science-based management support and monitoring systems. The essential characteristics of this approach are strongly interdisciplinary and require a focus on aspects of scale and cumulative processes to monitor and manage the impacts of autonomous processes and human activities on the unique natural values of the Wadden UNESCO World Heritage site.



## 1. Introduction

The Wadden Sea is one of the world's most valuable stretches of coastline. It extends roughly 500 km along the southeast coast of the North Sea from Den Helder in the Netherlands to Blåvands Huk in Denmark. The area contains the world's largest coherent intertidal flats: 4700 km$^2$ emerge at low tide. Its unique ecosystem is characterized by a rich benthic fauna supporting millions of coastal birds who visit over the course of a year and, due to its dynamic

☆ This publication forms part of the activities performed within the framework of the 'Wadden Sea Long-Term Ecosystem Research' (WaLTER) project, funded by the Dutch Waddenfonds and by the Provinces of Noord-Holland and Fryslân (www.walterwaddenmonitor.org).

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http://dx.doi.org/10.1016/j.ocecoaman.2015.10.004

nature, flora and fauna that change over time (De Jonge et al., 1993). Since 2009, the Dutch and German parts have been designated a World Heritage Site (WHS) and, in 2014, this designation was extended to include the Danish Wadden Sea and, an offshore area, the German Wadden Sea in Niedersachsen (see Fig. 1 and CWSS, 2008, 2012). The functioning of the Wadden Sea ecosystem has been addressed in numerous studies (for example, related to the WHS status, see Reise et al. (2010), Wolff (2013), Reise (2013) and references therein).

A large part of the intertidal area is sheltered by barrier islands and sand bars that protect it against the waves of the North Sea. The area includes 25 inhabited islands and several smaller vegetated islands and barren high sands. The total area of the islands is about 2000 km$^2$ and the Wadden Sea itself covers about 8000 km$^2$. The mainland is one of the oldest and most complex cultural landscapes in Europe and has been inhabited for more than 5000 years (Knottnerus, 2005; Vollmer et al., 2001). At present, an estimated 3.5 million inhabitants live in the 17,500 km$^2$ of land that is at risk of severe flooding (i.e. less than 5 m above and in places even below mean sea-level) (CPSL, 2010), while about 1 million inhabitants live on the islands and administrative regions directly bordering the Wadden Sea. As can be seen from Fig. 1, the WHS is limited to the Wadden Sea such that the Dutch islands and the main navigation channels fall outside. The exclusion of most estuaries forms a real problem because these river mouth systems may discharge pollution that can directly impact on the WHS. The major German ports of Hamburg, Bremen/Bremerhaven and Wilhelmshaven, the Dutch Eemshaven/Delfzijl and the Danish Esbjerg harbours are all home to important industries. Traditionally, the Wadden Sea region has been an important agricultural area. Tourism is a major source of income, especially on the islands (Sijtsma et al., 2012).

There is a rich literature on the management of the Wadden Sea (see Kabat et al., 2012 for an overview) but many of these studies focus on the management of its ecological system. Although Integrated Coastal Zone Management (ICZM) acknowledges that, in a coastal zone, not only the ecosystem but also the resources and human activities are important, the motivation for the latter's inclusion is that these human activities are seen as a main cause of the disruption of the natural coastal systems. Much less attention is paid to integrated forms of coastal zone management that target balanced economic development to provide future opportunities for people living and working there, while also generating surpluses for environmental protection measures (see, for example, De Jonge et al., 2012). A major implementation problem, especially when it comes to the management of the economic aspects, is the lack of up-to-date information at the trilateral level with regard to demographic changes, (un)employment and the structure of the regional economy. The available information is fragmented and limited to the national or regional scale in certain areas, or to specific economic sectors. A further problem is that, often, definitions of for example economic sectors are not consistent for small spatial areas in the three countries. The main aim of this paper is to gain insight into the demographic and economic developments in the coastal zone close to the Wadden Sea in order to provide information that can be used for coastal zone management that aims to achieve socioeconomic and ecological goals in a consistent way.

In Section 2, we provide an overview of the development of the various goals and management strategies employed in the Wadden area. In Section 3, we discuss the methodological considerations used in this study with regard to the development of a consistent

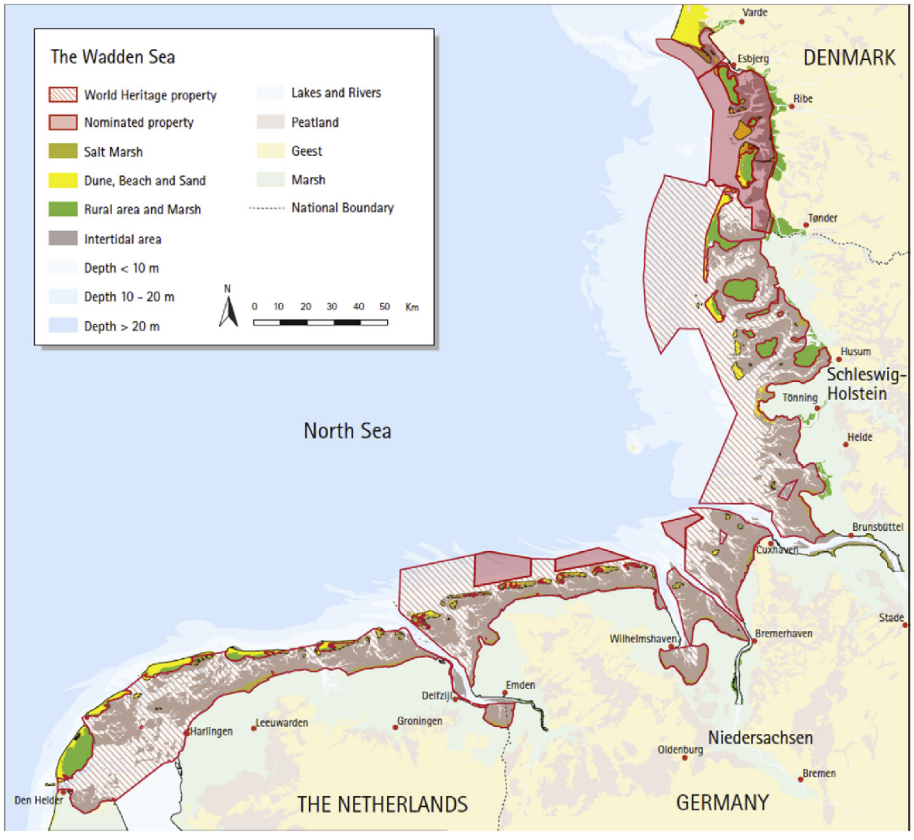


**Fig. 1.** The boundaries of The Wadden Sea World Heritage 2008 property and the nominated Danish and German extensions designated in 2014. Source: CWSS, 2012.

trilateral dataset for monitoring the demographic and economic situation at a small spatial scale. This concerns the demographic characteristics of people living in the Wadden area, in terms of specific age groups, and we address the role of in- and out-migration. This enables us to characterize the labour supply of the area. Following this, Section 4 addresses the area's regional economic development. Section 5 addresses the question as to what is the best strategy for integrated coastal zone management of the Wadden area given the phenomena of population decline and ageing in combination with a decrease in economic activities. Finally, Section 6 discusses the findings and draws conclusions.

## 2. Overview of the coastal management strategies and goals in the Wadden area

There is a rich literature on the management of the Wadden Sea (see Kabat et al., 2012 for an overview). Safety and protection against flooding have always been major issues in the Netherlands. The first large scale dyke-building and land-reclamation work started as far back as the 11th century and this changed the hydraulics and related processes such as water transport and erosion and sedimentation patterns in the Wadden Sea (Bazelmans et al., 2012; De Jong, 2011; Reise, 2005). When people behind the dykes began to feel safe, it also marked a significant change in the relationship between man and nature. This may have been a prerequisite for the perceptual shift from a threatening sea to a Wadden Sea that has become increasingly threatened by human impacts and consequently also deserving of protection (Fischer, 2011). The largest project to date has been the separation of the Zuiderzee (now the IJsselmeer) from the Dutch part of the Wadden Sea in 1932 by the construction of the Afsluitdijk to improve coastal protection and to gain agricultural land in the Netherlands. This completely changed the ecosystem of the former estuarine system and reduced the populations of diadromous fish (those that can live in both fresh and sea water) (De Beaufort, 1954; De Jonge et al., 1993). The almost one thousand year tradition of reclaiming land from the sea for agriculture slowly ceased in the second half of the 20th century as nature became more highly valued than economic gains (Wolff, 1992). The solid and visionary work of the Mazure committee led to the abandonment of plans for the total enclosure of the former Zuiderzee and the Wadden Sea, with dams between the barrier islands and across estuaries (Waddenzeecommissie, 1974). A cost-benefit analysis showed that reclaiming the land was not even economically profitable (Oosterhaven, 1981). Similarly, land reclamation for coastal protection in Germany came to an end in the 1980s.

As land reclamation stopped, there were growing concerns about the impacts of other human activities such as fisheries, hunting, military exercises, coastal protection, tourism and industrial development. These concerns led to the implementation of several policy measures to protect the ecological values of the region. In the new millennium, the discourse shifted from protecting nature towards one where nature development could go hand-in-hand with sustainable economic development (Runhaar et al., 2009; Reise, 2011; De Jonge et al., 2012). The turning point was the report by the Advisory Group on Wadden Sea Policy (Meijer Committee) published in 2004 (Adviesgroep Waddenzeebeleid, 2004). The committee found that the policy and management style adopted had been defensive, and that this had had the major unintended consequence of impeding the development and improvement of the natural environment, and that the economic development of the Wadden Sea region and the northern part of the Netherlands had been blocked. The committee believed that an integrated perspective based on prioritizing the natural environment but with limited shared human use was necessary in order to monitor and continue to develop the values and interests at stake.

Already for some time, it was being increasingly felt that, in addition to regional or national policy measures, an international approach was needed in order to protect the ecological values. As far back as 1974, the Dutch government were consulting with the Federal Republic of Germany and Denmark about international cooperation in protecting the Wadden Sea. These consultations ground to a halt due to disagreements between the federal and the regional state governments in Germany. To resolve the problem, it was agreed that scientists of the three countries should investigate the matter and this resulted in a report (Wolff, 1976) on the desirability of international Wadden Sea protection. In 1982, a Joint Declaration on the Protection of the Wadden Sea was agreed in which the three countries declared their intention to coordinate their activities and measures for the protection of the Wadden Sea. To facilitate this cooperation in nature management, a Trilateral Wadden Sea Cooperation (TWSC) was established in 1987, with a Council of Ministers that meets every three years at the Wadden Sea Governmental Conferences plus a Wadden Sea Board (WSB) that is the governing body of the Cooperation and supervises the Common Wadden Sea Secretariat (CWSS). In 1997, a Trilateral Wadden Sea Plan was adopted that defined shared management targets and this was updated in 2010 (CWSS, 1998, 2010).

Following a decision by the 9th Governmental Conference of the Trilateral Wadden Sea Cooperation in 2002, the Wadden Sea Forum (WSF) was established. Although the WSF (2010) has a broader scope than the TWSC, the two organizations are working together in many fields and they share a building in Wilhelmshaven. Nevertheless, the WSF is constituted as an independent platform of stakeholders from Denmark, Germany and the Netherlands to contribute to an advanced and sustainable development of the trilateral Wadden Sea Region. In particular, this involves integrating specific environmentally sound, economically viable and socially acceptable cross-sector and trans-boundary strategies, actions and techniques. The WSF includes representatives from the sectors agriculture, energy, fisheries, manufacturing and harbour, nature protection and tourism, as well as from local and regional governments. National governments are present as observers (WSF, 2010).

Whereas the TWSC has focused mainly on the conservation of ecological values within the Wadden Sea, the WSF has a broader goal – in line with the ideas of the Meijer Committee – to help achieve a sustainable society by 2030 in which economic activity supports social development and safeguards healthy ecosystems and culturally historic landscapes throughout the Wadden Sea region (see Fig. 2). The Wadden Sea region encompasses the coastal zones, the Wadden Sea, with its islands and sands, and relevant parts of the offshore Exclusive Economic Zones (EEZ) of Denmark, Germany and the Netherlands. As Fig. 2 shows, the coastal zones are rather large and differ in size in each country. The most suitable spatial demarcation in the Wadden area depends on the topic in hand and the availability of data. In our study, we consider population and labour market characteristics of the Wadden area, which we see as covering the area in which the role – and hence influence – of the Wadden Sea can still be felt. For this, we need an adequate representation of the Wadden area, one that allows for possible effects of the Wadden Sea on the coastal Wadden area, and *vice versa*. Below, we argue that a much narrower demarcation than that shown in Fig. 2 of the coastal Wadden area provides a much better link between the Wadden Sea and the surrounding coastal area. Conversely, Fig. 1 excludes relevant socioeconomic areas. It is difficult to assess the influence of the Wadden Sea on populations and employment changes in areas that are some distance from the Wadden Sea, such as in the city of Groningen. While the impact of the Wadden Sea on nearby ecosystems may decrease fairly rapidly, when considering

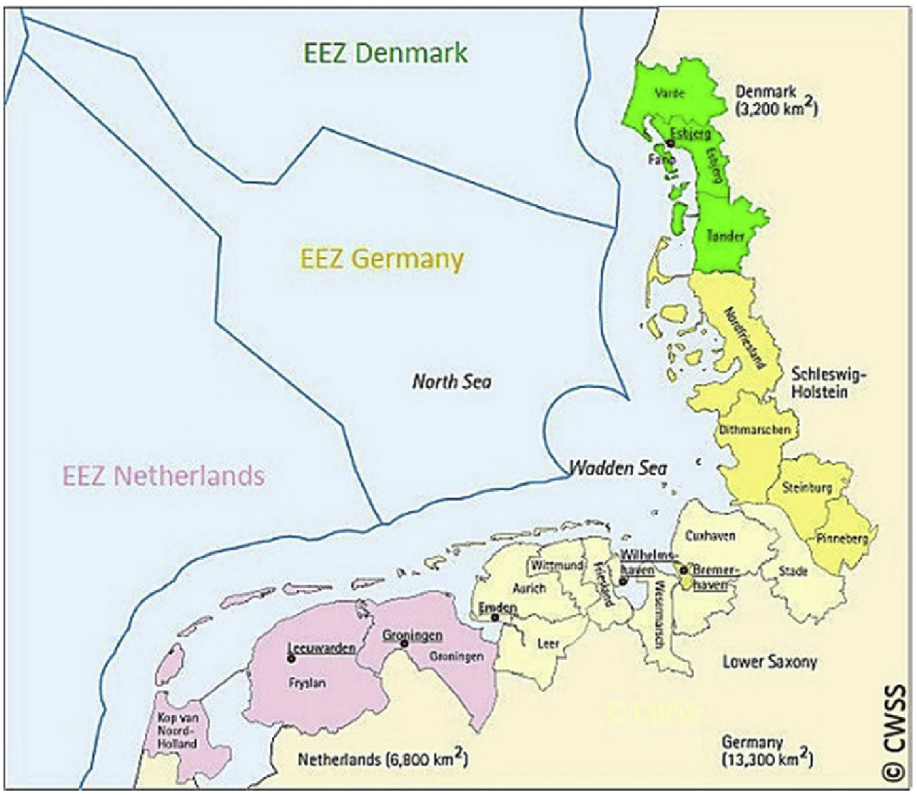


**Fig. 2.** The Wadden Sea Region encompasses the coastal zones, the Wadden Sea with its islands and sands, and parts of the offshore Exclusive Economic Zones (EEZ) of Denmark, Germany and the Netherlands.
Source: Common Wadden Sea Secretariat (CWSS) website http://www.waddensea-forum.org/index.php/forum/wsf-region August 15, 2014.

aspects such as employment opportunities then a much wider area is within commuting distance and therefore relevant.

Humans occupy and use the area, and consequently put direct pressure on the ecosystem (e.g. through fisheries) and also apply indirect pressure to its physical (dredging and channel deepening) and chemical subsystems (e.g. pollution) as described by De Jonge et al. (2012). The effects of this are many and complex and, consequently, the system needs to be managed so that both the ecosystem and the social system can develop in a sustainable way. This in itself is a real challenge for integrated coastal zone management in the broader sense. Proper management can only be applied if there is sufficient ecological and socioeconomic information and knowledge to manage this integral system (see e.g. De Jonge et al., 2012; Kabat et al., 2012; Giebels et al., 2013). In addition to scientific knowledge, participatory knowledge and practices are also increasingly required to facilitate the integration of different types of knowledge (e.g. formal and informal), and the inclusion of a range of stakeholders to enhance the ICZM (Puente-Rodríguez et al., 2015a). It is clear that knowledge is a key feature in achieving ICZM, but also that the decision-making process is important. De Jonge and Giebels (2015) argue that significant changes in the decision-making process and the ways in which scientific models are used to support these decisions are needed to explore potential improvements.

While there are many ideas stemming from environmental disciplines on managing the Wadden Sea as a natural system, there is a real knowledge gap when it comes to the economics. A recent overview addressing many aspects, but not the economy, can be found in a volume published by Ocean & Coastal Management (Van Leeuwe and Haartsen, 2012). The studies that do offer insight into the socioeconomic situation and developments in the trilateral Wadden Sea region are very limited and not very recent. Arndt et al. (2004) is one of the exceptions. These authors present figures on demographic developments, the regional economic structure and the labour market over the period 1990–2000. Their study indicates that the massive demographic shift due to population decline and ageing will have a strong social and economic impact on the region. The regional economic structure will change from manufacturing to services, and also within manufacturing and services major changes will take place. Employment is expected to continue to fall in agriculture and fisheries. Nevertheless, along with tourism, these sectors do provide employment where often other job opportunities are limited, resulting in high unemployment in several sub-regions. The intensification of international competition and the increasingly knowledge-based economic activities require innovative business developments and employees with appropriate skills and qualifications. These authors also stress that the Wadden Sea region is heterogeneous in being situated in three countries and various sub-regions with different local foci and that, therefore, future strategies will have to address the regional differences between the sub-regions. Enemark (2005, p.1009) also stated that the Wadden area "is characterized by having a weak economic and social development with lower economic growth rates and higher unemployment rates than the average for the Wadden Sea countries". He stressed that stakeholders have always considered the Wadden Sea protection schemes as potentially hampering economic developments in the region, and that the management principles and the targets have often been over-focused on environmental development rather than on an integrated coastal zone management that aims to allow both the ecosystem and the social system to develop in a sustainable way.

The Wadden Sea Forum has adopted integrated coastal zone management (ICZM) as a process for achieving sustainable development of the Wadden Sea Region in a way that is environmentally sound, economically viable and socially beneficial. The increasing uses made of the offshore Exclusive Economic Zones (EEZ) beyond the protected Wadden Sea have led the WSF to enlarge the spatial scale of its work regarding ICZM objectives. Comparing Figs. 1 and 2 emphasizes that the WHS property (Fig. 1) is restricted to the Wadden Sea, whereas the Wadden Sea Region (Fig. 2) covers a much larger area and is more relevant to integrated management of ecological and economic perspectives.

In particular, this management involves integrating specific cross-sectoral and trans-boundary strategies, actions and techniques in order to facilitate the coordinated growth and implementation of trilateral strategies and action plans with regard to spatial planning, infrastructure, transport, agriculture, fisheries, tourism, coastal defence, shipping, port facilities, social services, nature protection and any other policy areas that have a possible impact on the sustainable development of the Region. The related ICZM strategy is documented in the ICZM Strategy for the Wadden Sea Region (WSF, 2013).

The WSF ICZM strategy aims to achieve a balanced population structure with a healthy share of young and elderly people, with indigenous young people choosing to stay in the region and further population decline being avoided. The WSF also strives for near full employment which requires a wide diversity of jobs for residents ranging from high-level professionals to those seeking manual employment. In terms of welfare, WSR residents should have adequate income, good living conditions and a high life expectancy. Social equality and a good work-life balance should ensure a satisfied population. All this requires a balanced economic development that provides future prospects for people living and working in the area, but one that should also generate surpluses for environmental protection measures. The economy in the WSR should be designed to be resilient to economic recessions and international competition through the adoption of strategies for innovation and entrepreneurship. This is outlined in more detail for specific sectors (WSF, 2013). As an example of progress, the ministers in the Wadden Sea Council meeting at the 2014 Trilateral Governmental Conference in Tønder adopted a joint strategy for "Sustainable Tourism in the Wadden Sea World Heritage Destination" (CWSS, 2014). This strategy has been developed at the request of the World Heritage Committee using a participatory approach, and a solid transnational network of stakeholders has been established over the last two years that will provide the framework for implementing this joint strategy.

A major problem, especially with the implementation of the economic aspects of the ICZM, is the lack of up-to-date information at the trilateral level with regard to demographic change, (un) employment and the structure of the region's economies. The available information is fragmented and in some areas only available at the national scale or, where it is more detailed, only for specific economic sectors. A problem is often that definitions of, for example, economic sectors are not consistent for small spatial areas in the three countries. Comparable information is often only available at the larger NUTS-2 regional level from Eurostat. The Wadden Sea Region as defined in Fig. 2, especially in the Netherlands and parts of Germany, is made up of rather large administrative regions whereas information is needed at the more-detailed geographical scale of municipalities or parishes for effective ICZM. This issue will be discussed in detail in the next section.

This is the first study where the socioeconomic situation of the entire Wadden area, across all three countries, is addressed in a unified way. Further, the regional demarcation of the area is sufficiently refined to assume a strong relationship between the ecosystem in the Wadden Sea and the demographic and socio-economic situations for inhabitants in the coastal zone. Here, we will make use of data for relatively small areas so that we are able to distinguish between the islands and the mainland bordering the Wadden Sea, and also compare these to the national situations. The paper now proceeds to analyse the development over time of the population, labour supply and labour demand in relation to the structure of the regional economy in the Wadden area in order to assess the economic and social performance of the Wadden area, and its strong and weak points. We start with some methodological and data considerations.

## 3. Methodological and data considerations

In this paper, the Wadden area is studied using local data on several demographic and socioeconomic aspects. We analyse population and labour market statistics and specifically distinguish between the coastal areas of the three countries on the mainland because of their different demographic and economic characteristics and the geographical settings in terms of accessibility and economic assets. It is very important to define the coastal zone in an appropriate way if one is aiming for ICZM that enables both the ecosystem and the social system to develop in a sustainable way. Ketchum (1972) defines the coastal zone area as: "the band of dry land and adjacent sea space (water and submerged land) in which terrestrial processes and land uses directly affect ecosystem processes and uses, and *vice versa*". There will be issues linked with the diversity of features present on the coast and the spatial scales of the interacting systems. Unless ICMZ is aiming at the sustainable development of both the ecosystem and the social system, it is only because human activities disrupt the natural coastal system that they warrant inclusion in ICZM. In reality, many activities in coastal municipalities face inland rather than the seashore since the main economic activities are located inland. These activities, such as education and shopping, are typically related to the population living in the area. Most employment-related activities also tend to be directed inland.

In our study area, many such activities are not even located in the municipalities bordering the Wadden Sea but are in the larger cities nearby such as Leeuwarden and Groningen in the Netherlands, Oldenburg, Bremen and Hamburg in Germany, and Danish cities such as Billund and Kolding. The Danish city of Esbjerg is the only major population centre in the entire Wadden Sea Region (see Fig. 2). Since most economic activities in municipalities along the Wadden coast are directed towards such cities, we can say that most of the activities in the municipalities on the Wadden coast do 'face inland' and not towards the Wadden Sea. Only municipalities that include a significant harbour can be seen as also facing the Wadden Sea, but often their focus is beyond the coastal waters into the North Sea and beyond. The important harbours in the Wadden area, as we have defined it, are Esbjerg, Bremerhaven, Wilhelmshaven, Emden, Delzijl/Eemshaven, Harlingen and Den Helder. Other harbours, including Bremen and Hamburg, and the important Meyer shipyard in Papenburg are all close by but do not fall within our narrow demarcation of the Wadden area.

The harbours have activities that are located at or related to the Wadden Sea. These are not only activities such as fishing and shipping, but also related activities such as shipbuilding and repairs, goods storage, handling the arrival and departure of vessels, running ferry services to and from the islands and rescue services. These harbour towns have many activities directed towards the Wadden Sea, and because industrial sites are developed with large-scale industrial activities close to the harbour there is a heightened risk of negative effects on the vulnerable ecosystem. The same is true for the various inhabited islands in the Wadden Sea in all three

countries. The inhabitants of the islands depend to a large part on facilities on the mainland and, in that sense, ferry services are important. The islands are also major centres for tourism, and tourism is also an important economic activity for some mainland municipalities bordering the Wadden Sea, especially in Germany (see also, Sijtsma et al., 2008).

To add to the complexity of ICMZ, the administrative units often use arbitrary boundaries that dissect the zone, often leading to fragmented management. For our analysis, we require statistical data on the demographic and economic processes at a detailed spatial scale that is in line with the Wadden area in terms of demarcation and boundaries, and the spatial scale of the demographic and socioeconomic developments in which we are interested. Our aim is to analyse the development over time of population, labour supply and labour demand in relation to the national situations in order to understand economic and social performance in the Wadden area and its strong and weak points. If we were to use larger areas in our analysis, the link with the Wadden Sea would decrease and may even get lost. Therefore, we use data for relatively small areas so that we can distinguish between the islands and the mainland directly bordering the Wadden Sea and compare these areas with the national situation.

In determining the spatial unit of analysis, the classification system used by the European Union is a good starting point because considerable statistical data are organized using this spatial approach. For each EU member country, a hierarchy of three NUTS (Nomenclature of Units for Territorial Statistics) levels has been established by Eurostat. It should be noted that the subdivisions do not necessarily correspond to recognized administrative divisions within a country. The NUTS classification in force at the time of the research involved 97 NUTS-1 level regions, 270 regions at NUTS-2 and 1294 NUTS-3 level regions across the entire EU. Two further levels of Local Administrative Units (LAUs) are defined: LAU-1 and LAU-2, which correspond to the earlier NUTS-4 and NUTS-5 classifications. The NUTS-LAU levels can be seen as corresponding to the following administrative units in the Netherlands, Germany and Denmark, respectively:

- NUTS-1: Groups of provinces (Landsdelen); States (Bundesland); the entire country
- NUTS-2: Provinces; Government regions (Regierungbezirk); Regions (Regioner)
- NUTS-3: COROP regions; Districts (Landkreis); Areas (Landsdele)
- LAU-1: COROP regions (i.e. same as NUTS-3); Collective municipalities (Verwaltungs-gemeinschaften); Municipalities (Kommuner)
- LAU-2: Municipalities (Gemeenten); Collective municipalities (Gemeinden); Parishes (Sogne)

The Wadden Sea Region, as defined by the Wadden Sea Forum (Fig. 2), amounts to a kind of patchwork of different types of administrative units. In the Netherlands, it comprises two entire provinces (NUTS-2) and the most northern part of the province of Noord-Holland (NUTS-3). In Germany, the Region includes parts of three bundesland (NUTS-1): four regierungbezirke (NUTS-2) in Schleswig–Holstein; seven regierungbezirke in Lower Saxony; and the two Kreisfreie Städte (urban districts) of Wilhelmshaven and Emden plus Bremerhaven (NUTS-2) which are part of Freien Hansestadt Bremen. In Denmark, four Kommuner (LAU-1) fall within the Wadden Sea Region. As such, the Wadden Sea Region consists of a complicated conglomerate of regions of different sizes and rankings in the hierarchy of governmental structures. This has implications when it comes to collecting appropriate statistical data for our analysis. For our analysis, we would ideally use data at the LAU-2 level. Analysing the Wadden area at the LAU-2 level would expose the possible role of the population and the employment activities of the inhabitants of the coastal zone in direct relation to the ecosystem. This effect may become blurred if the analysis is based on larger areas. For the Netherlands and Germany, this is relatively easy because this is the level of municipalities, which are administrative units for which statistical data are often available. However, it is more problematic when it comes to the Danish parishes (*sogne*). Danish parishes originated in the Middle Ages, beginning in 1645 when Danish pastors were required to maintain parish registers, which in modern times have become a valuable source in genealogical research. However, since the 1970 municipal reforms, parishes are no longer an administrative unit and this leads to some data limitations as discussed later.

In our analysis, we will therefore use this smallest possible regional unit for which statistical data are available. The area is thus made up of 174 LAU-2 areas that directly border the Wadden Sea or are on the Wadden islands as shown in Fig. 3. Including the islands, the Dutch component of the Wadden area comprises 19 LAU-2 areas (i.e. municipalities),[1] the German area comprises 124 LAU-2 areas (municipalities) and the Danish area consists of 31 LAU-2 areas (parishes). Although all these areas are on the LAU-2 level, those in Germany (particularly in Schleswig–Holstein) and the Danish parishes on the Wadden coast are physically smaller than those elsewhere (see Fig. 3).

The Wadden area includes 20 inhabited islands (5 in the Netherlands, 12 in Germany and 3 in Denmark). Some of the German and Danish islands include more than one LAU-2 area. In such cases, the data have been aggregated to give a total for the entire island. The five Dutch islands were each a distinct LAU-2 area (municipality) so this was not necessary. Uninhabited islands or those with very few inhabitants (and which therefore did not achieve LAU-2 ranking) were excluded from the analysis but this is not seen as problematic since there are no, or only very limited, human activities. The Wadden area that we analyse is depicted in Fig. 3 and is substantially smaller than that of the Wadden Sea Region, as shown in Fig. 2, used by the Wadden Sea Forum. We would argue that our smaller, more refined, area is better suited for the specific demographic and economic issues we will analyse.

We were able to access population statistics on the LAU-2 level for all three countries. However, when it came to labour market statistics, data on this level was only available for the Netherlands and Germany. For Denmark, we had to fall back on data on the LAU-1 level. Although areas on the LAU-2 level in both Germany and the Netherlands and on the LAU-1 level in Denmark all refer to terms that can be translated as municipalities, those in Denmark are much larger as reflected in the classifications. A number of economic phenomena that we would like to distinguish, such as output in terms of GDP or economic growth, capital investments, R&D and innovation, are simply not observed on the municipality level in any of the countries. Here, we were forced to use a higher level of spatial aggregation, typically on the NUTS-3 level.

[1] In 2009, the Netherlands significantly reduced the number of municipalities in its administrative system, including major revisions to some municipalities in the Wadden area. These revisions have resulted in the new municipalities of Hollands Kroon in the province of Noord-Holland, Zuidwest Fryslân in the province of Fryslân and Oldamt in Groningen (see Fig. 10) that border the Wadden Sea but with only a very small part of their territory adjacent to it. Therefore, for the purposes of our analysis, we attempted to 'calculate back' to the 'old' municipality demarcations of the period prior to 2009. This was possible in terms of areas and municipal populations, but not for municipal employment levels so these had to be based on the new municipality demarcation.

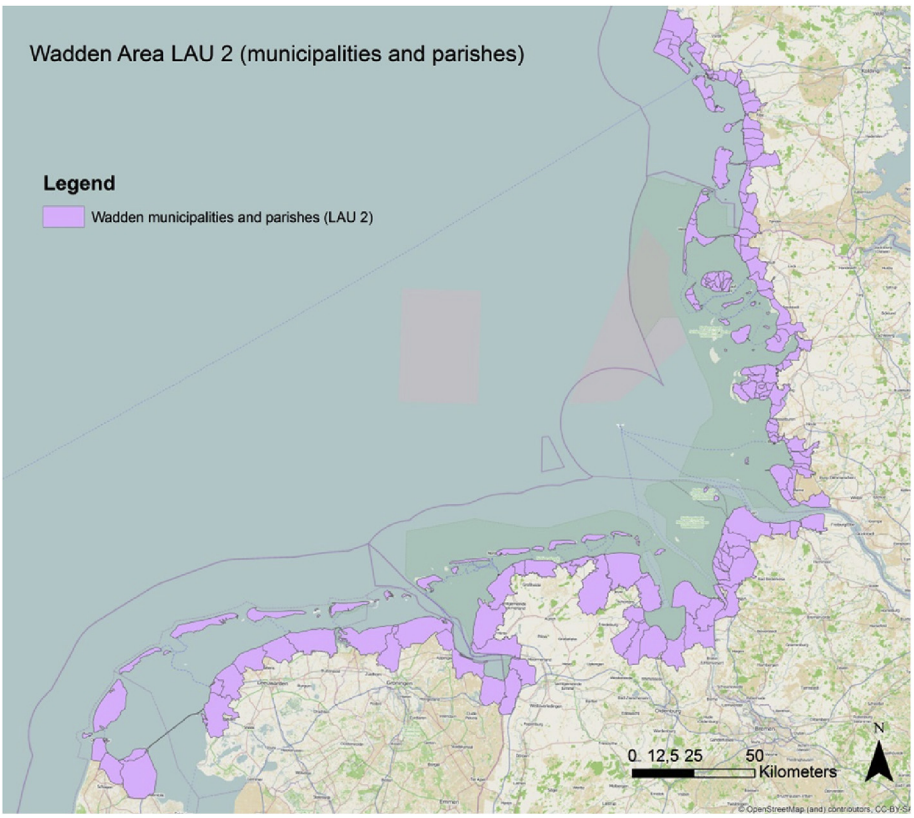


**Fig. 3.** Demarcation of the Wadden area (LAU-2 classification), 2013.
Source: Eurostat.

## 4. Population and potential labour supply

### 4.1. Overall picture

As of January 2013, the total Wadden area (mainland plus islands) based on these LAU-2 areas of the Netherlands, Germany and Denmark together held about 1 million inhabitants (see Table 1). Of these, about 78,000 lived on the islands. Overall, the Wadden area is home to about 1% of the total population of the three countries. In Germany, the percentage is slightly below this average, and in the Dutch and Danish components nearer to 1.5%. Therefore, in terms of population, this is a relatively insignificant area. Moreover, the population is falling, with negative growths in all three country components between 2002 and 2013.

Fig. 4 shows the average annual percentage change in population for all LAU-2 areas of the Wadden area over the period 2002–2013. It shows that while the population in some scattered municipalities might still be growing, the majority of the Wadden municipalities saw a declining population. The population on most the Wadden islands shrunk in the period addressed. Fig. 4 also illustrates the earlier comment regarding the relative sizes of the LAU-2 areas in the three countries.

Table 2 shows the population in 2013 and the population growth between 2002 and 2013 broken down into three age groups in the Wadden area and on the islands for the three countries separately. Table 2 distinguishes the age groups of 0–14 (children), 15–64 (working age) and 65 and older (pensioners). We can derive from Table 2 that the proportion of pensioners on the Dutch Wadden islands (≈20%) is lower than in the other countries (≈25%). Further, this is the only age group that is increasing in numbers on the Wadden

**Table 1**
Human population 2013 and average annual population growth 2002–2013 of the Wadden Sea area and the Wadden Sea islands.

| | Inhabitants (1-1-2013) | | Average annual population growth 2002–2013 (%) |
|---|---|---|---|
| | Wadden (1000s) | National (millions) | |
| **Wadden area** | | | |
| NL | 268.8 | 16.6 | −0.29 |
| DE | 662.5 | 81.0 | −0.31 |
| DK | 80.1 | 5.5 | −0.10 |
| Total Wadden area | 1011.5 | | −0.29 |
| **Wadden islands** | | | |
| NL | 22.9 | | −0.10 |
| DE | 51.3 | | −0.28 |
| DK | 3.9 | | −0.16 |
| All islands | 78.1 | | −0.22 |

Source: Statistics Netherlands; Statistics Denmark; national and regional German statistical agencies.

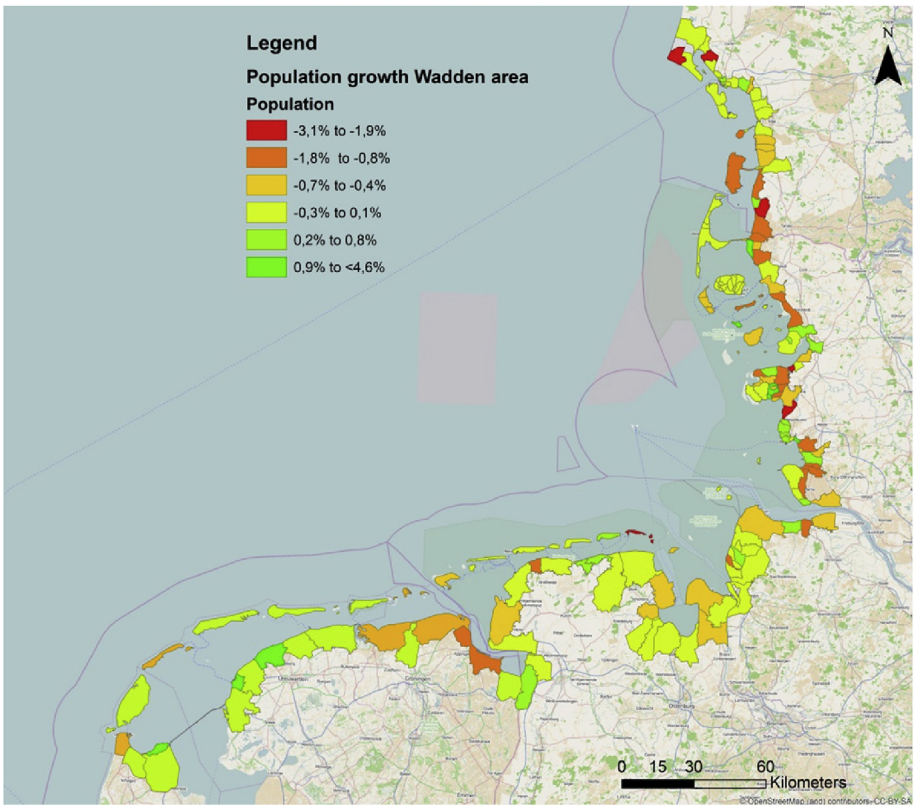


**Fig. 4.** Average annual population growth, 2002–2013, of the Wadden area (LAU-2 classification).
Source: Eurostat.

areas and islands in all three countries. Moreover, the working-age populations are seeing the largest falls in absolute terms.

### 4.2. Population development by age group in the Wadden area

The figures by age group in Table 2 indicate that the Wadden area shares a serious problem facing the entire western world: a rapidly ageing population. Ageing is defined here the number of persons over 65 as percentage of the total population.[2] Fig. 5 shows this ageing in the three countries bordering the Wadden area in the long run. In Germany ageing has the highest level and strongest rise. In fact, one third of the population is expected to be 65 and older by 2020. This threshold is expected to by passed in Denmark and the Netherlands some ten years later. In many countries, ageing is seen as a problem because pensions for the elderly are financed by taxes on the income of persons of a working age. Under this financing system, ageing might become problematic, as the proportion of ageing exceeds 33%. The underpinning premise is that ageing becomes a problem when each pensioner has less than two people taking care of their financial needs. Indeed, provided these two people are working this should not be a problem. However, there is no guarantee that these other two persons will be holding a job. They might be unemployed, or are still at school, or may even still be babies and thus have no income.

Naturally, these national statistics hide regional differences. On the edges of these three countries, ageing has a different momentum than Fig. 5 suggests. In the more remote regions, such as the Wadden coast, ageing is already becoming a serious problem. The question is what we can say about the rate at which the population is ageing in the Wadden area compared to in the countries of which it is part. In order to capture national ageing and ageing in the Wadden area in one figure, we compare the proportion of people over 64 in the Wadden area with the national figures. We calculate the difference between the two figures so that we can instantly see whether the Wadden area has a relatively aged populated compared to the countries as a whole.

Taking all this into account, Fig. 6 plots the percentage of those aged 65 and above in all three Wadden areas (including the islands)

**Table 2**
Composition of the human population on January 1, 2013 and its growth between 2002 and 2013 in Wadden area and on Wadden islands (based LAU-2 classification).

| | Population by age group at Jan. 1 2013 (× 1000) | | | | Average annual population growth by age group 2002–13 (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | 15–64 | >64 | <15 | Total | 15–64 | >64 | <15 |
| **NL** | | | | | | | | |
| Wadden area | 268.9 | 171.8 | 51.5 | 45.6 | −0.29 | −0.71 | 2.56 | −1.32 |
| Wadden islands | 22.9 | 14.5 | 4.7 | 3.7 | −0.10 | −0.60 | 3.28 | −1.44 |
| **DE** | | | | | | | | |
| Wadden area | 662.5 | 426.0 | 159.9 | 83.1 | −0.31 | −0.51 | 1.70 | −2.39 |
| Wadden islands | 51.3 | 33.4 | 12.6 | 5.3 | −0.28 | −0.74 | 2.48 | −2.55 |
| **DK** | | | | | | | | |
| Wadden area | 80.1 | 51.3 | 16.1 | 12.7 | −0.10 | −0.36 | 2.29 | −1.56 |
| Wadden islands | 4.0 | 2.3 | 1.1 | 0.6 | −0.16 | −1.29 | 4.07 | −1.57 |

Source: Statistics Netherlands; Statistics Denmark; national and regional German statistical agencies.

[2] This differs from official definitions. Our definition is easier to compute for the many municipalities in the Wadden area for which the number of inhabitants by age group is not always available. Our definition does have the same characteristics as the official one. See http://www.un.org/esa/population/publications/worldageing19502050/pdf/95annexi.pdf.

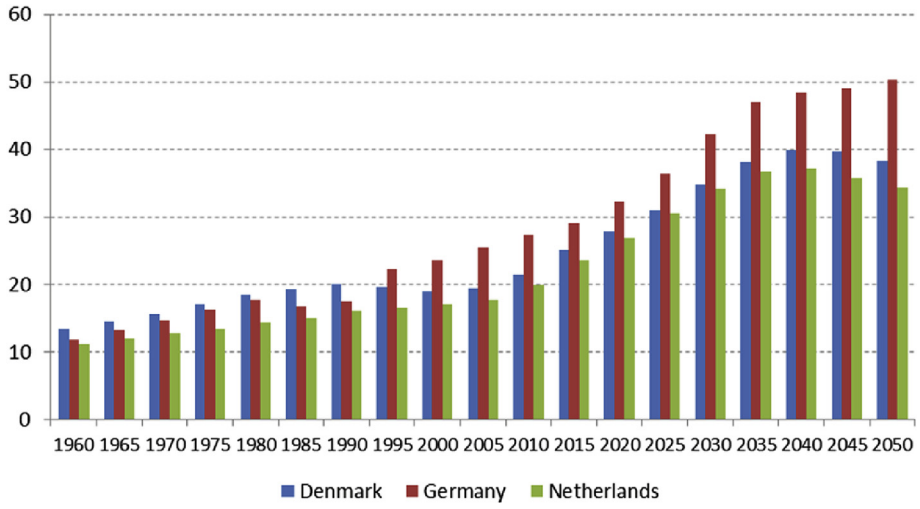


**Fig. 5.** Ageing, defined as population of 65 and older, as percentage of total population.
Source: Eurostat.

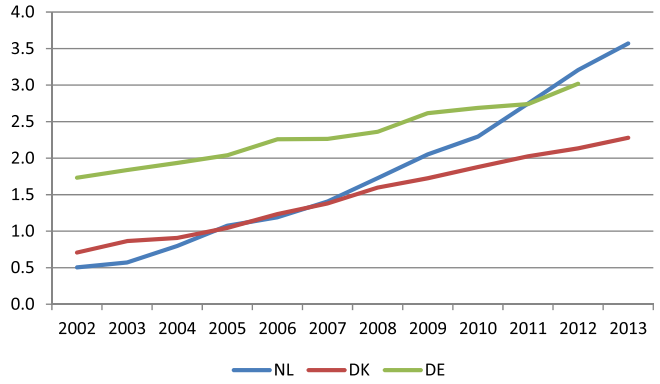


**Fig. 6.** Rate of ageing in Dutch, German and Danish Wadden area, relative to the respective national rates of ageing.
Source: Statistics Netherlands; Statistics Denmark; national and regional German statistical agencies.

less their respective national figures for the period 2002–2013. So the Y-axis represents the relative change in the ageing population in the Wadden area compared to national averages. So for example, in 2002, the Dutch Wadden area's population contained 0.5%-points more elderly people than national. The upward trends in all three countries over time indicates that the Wadden area's population is becoming increasingly more aged than that of the entire countries. Although the trends in all three countries are upwards, the rates do differ between the different Wadden areas. While the slope of the relative ageing curves for the German and Danish Wadden are similar, relative ageing in the Dutch Wadden area has increased at a much steeper rate. So, while the Dutch part had the lowest "excess" of elderly people in 2002, by 2012 it had the highest relative ageing of all Wadden areas. So, ageing in the Dutch Wadden area, relative to national ageing, appears to be becoming a problem much faster than in the other two Wadden areas. Although separate figures for the Wadden islands are not presented here, the picture is similarly one of strong and ongoing ageing populations, this time particularly on the Danish islands.

Another issue is the so-called relative rate of rejuvenation in all three Wadden areas. This is measured here as the share of the population under 15 years of age relative to the national averages. As with the ageing figures above, a positive rate indicates a higher proportion of youngsters in the total population of the Wadden area relative to the national figure, while a negative rate means a lower share of youngsters in the Wadden relative to national share. Alongside a growing elderly population, a decrease in the number of young people who can eventually join the workforce poses another problem for the area. These relative rates of rejuvenation are shown in Fig. 7.

Clearly, in general terms, Fig. 7 shows an opposite trend to the ageing patterns of Fig. 6. While the Wadden area has increasingly more elderly people than the countries as a whole, it has increasingly fewer young people as a proportion of the population. All the rates of rejuvenation fell between 2002 and 2013 relative to national rejuvenation rates. However, whereas ageing rates outstripped national averages in all three areas over the entire people analysed, rejuvenation rates in the Dutch and German regions were slightly above the national averages in the early part of the period studied. However, by 2009, all three Wadden areas were seeing rejuvenation rates below the national averages. A major cause for this is that birth rates have been consistently lower in the Wadden area than nationally. As with ageing, the islands show a similar pattern to the Wadden area as a whole.

The patterns outlined above could be caused by people migrating towards the Wadden area on retirement, or people younger than 65, especially families with young children, migrating out leaving elderly people behind. To shed more light on this, Fig. 8

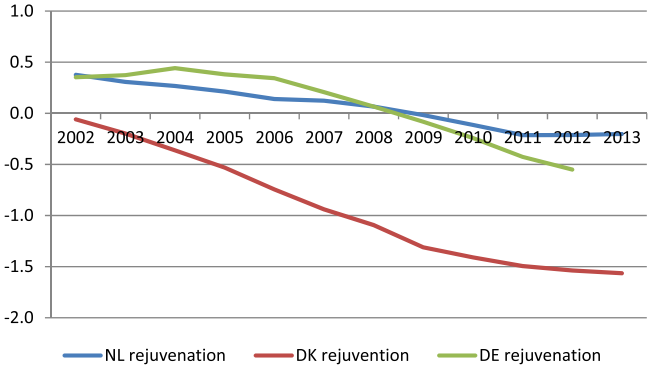


**Fig. 7.** Rate of rejuvenation in all three Wadden areas, relative to national rates.
Source: Statistics Netherlands; Statistics Denmark; national and regional German statistical agencies.

shows the net migration of people, by age, moving into or out of the Dutch Wadden area in 2003 and 2013. We calculated corresponding figures for the intervening years but these were consistent with the trends in the figure so not shown for convenience. Fig. 8 shows substantial net out-migration from the Dutch Wadden area, particularly of people between 15 and 30 years of age. This group will include those moving to secondary or tertiary educational institutions or finding work further inland. Since the early 2000s, around one thousand people aged between 15 and 30 have left the Dutch Wadden area each year, and the trend is upwards. Fig. 8 also shows a change in the migration pattern of those aged above 30. In 2003, there was a small net in-migration of that group towards the Wadden area but, by 2013, this had changed into a substantial out-migration. Nevertheless, despite this change, out-migration is still much stronger among younger people and this leads to the growing proportion of elderly people reflected in Fig. 6.

The patterns of ageing, rejuvenation and migration together influence the size of the labour force in the Wadden area. Fig. 9 shows the proportion of the population who are of working age (i.e. the population aged 15–64 as a percentage of the total population) in the Wadden area relative to national figures. This working age population serves as a measure of labour supply. The graph shows that, in all three countries, the Wadden area has relatively fewer people of working age than the national situations. That is, the potential labour supply is relatively low. One observation from the figure is that the 'shortfall' in potential workers has been relatively consistent in the German (≈-2.5%) and the Danish (≈-0.5%) Wadden areas. In the Dutch Wadden area, however, there has been a steady increase in the shortfall from close to the Danish rate in 2002 to approaching the German rate in 2013. This reflects the findings shown in Fig. 8 that many within this age category have migrated from the Dutch Wadden area to (find) work or enrol in education elsewhere.

## 5. Labour market of the Wadden area and regional economic structure

### 5.1. Employment indicators in the Wadden area

Alongside population by age and labour supply, we consider employment within the Wadden area for the period 2002–2011. To an extent, the level and any changes in employment depend on how employment is defined and the regional economic structure. Broersma and van Dijk (2002) clearly show that the dynamics and adjustment processes on the regional labour market in the North of the Netherlands differs substantially from the rest of the Netherlands and Delfmann et al. (2014) found that e.g. new firm

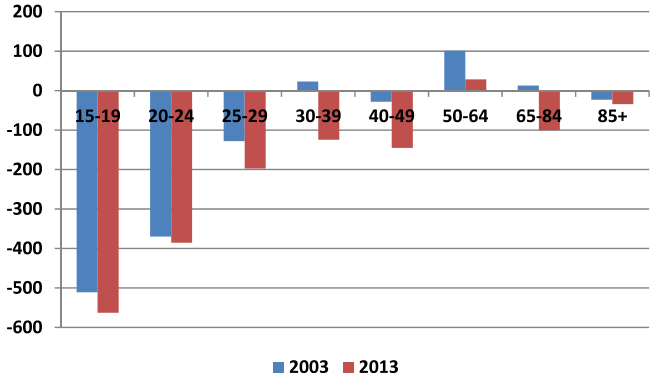


**Fig. 8.** Net migration by age group in the Dutch Wadden area, 2003 and 2013.
Source: Statistics Netherlands.

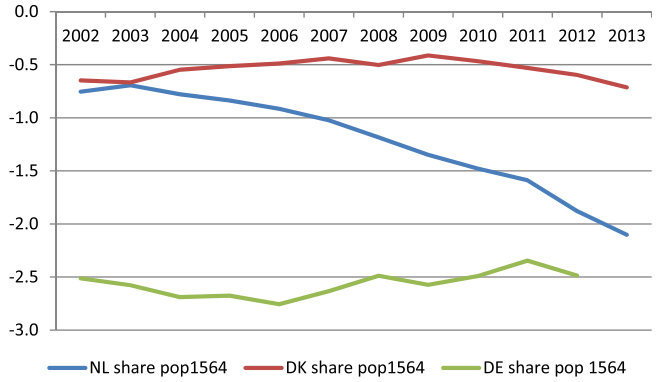


**Fig. 9.** Proportion of population of working age (15–64) in all three Wadden areas relative to national rates.
Source: Statistics Netherlands; Statistics Denmark; national and regional German statistical agencies.

formation differs between rural and urban areas and regions with population decline or growth. There are essentially two basic starting points for defining employment. First, employment can be defined as the number of employed persons living within an area.[3] The second definition of employment is based on the number of jobs located in an area.[4] Both employment definitions leave questions over how to deal with people living in one area but working in another. In other words, commuting patterns are a complicating factor in drawing conclusions about the labour market situation. Unfortunately, reliable data on commuting are not available at the spatial level of our research in any country. Another indicator that is frequently used in describing a regional employment situation is the so-called employment rate, which is defined as the number of jobs as a percentage of the inhabitants of working age (between 15 and 64). This indicator reflects how many jobs are available for the labour force in an area, and effectively ignores commuting. This employment rate is used by the European Union as its main policy target indicator for describing the labour market opportunities in a region. In the Lisbon strategy formulated in 2000, the EU set a target for the overall employment rate at 70% for 2010. Another issue when looking at the municipality level is that the Dutch and German employment figures are available on the LAU-2 level, whereas Danish figures are only available at the LAU-1 level. As such, the basic areas in Denmark are physically larger and this will reduce the level of inter-regional commuting. This section only considers employment in terms of the actual number of jobs in the Wadden municipalities and on the islands.

[3] This corresponds to the definition of the employed labour force, as determined in the so-called Labour Force Survey (LFS) in all European countries. To aid comparison, Eurostat uses a unified definition of the employed labour force across all European countries: the number of people aged 15–64 that work for at least 1 h a week. National statistical agencies may have different definitions. While Denmark and Germany use this definition, the Netherlands defines it as the number of 15–64 year-olds working at least 12 h a week. Eurostat data are not available at the municipality level, and the LFS is based on a relatively small survey. Hence, employment data are often missing for small areas and particularly for small municipalities.

[4] Unlike the definition of being employed, there is no minimum hours limit when defining a job. Job surveys are generally more comprehensive than the LFS, so there is less of a problem with missing data. However, an issue that affects our research is that the German statistical agencies at the municipality level only count the number of registered jobs and exclude the self-employed. To align the German figures with those for Denmark and the Netherlands (that do include the self-employed at the municipality level), we adjust the German figures to reflect the ratio of employed to self-employed in the relevant NUTS-3 (Landkreis) regions for which data are available. Naturally, there is some uncertainty over the accuracy of this approach.

Table 3 gives an overview of some important labour market indicators, such as the number of jobs, employment function, the unemployment rate, the annual percentage growth in jobs between 2002 and 2011 and the distribution of jobs across a range of industries. We start by looking at the number of jobs. About 1.2% of all jobs in the Netherlands are located in the Wadden area, which is home to about 1.5% of the total population. The employment situation is more favourable in the German Wadden area, which has 0.9% of all German jobs but only 0.8% of the total population. A similar comparison cannot be made for the Danish Wadden area because population is observed at the LAU-2 level and jobs at the LAU-1 level. It is almost impossible to make a clear assessment of the situation on the islands because many jobs on the Wadden islands are seasonal and often filled by workers who reside on the mainland but have temporary accommodation for the summer season on the islands.

Despite the falling populations in the Wadden area (see Table 2), Table 3 still shows positive job growth rates for the Dutch and German parts. Although the growth was below the national rate in the Dutch Wadden area, it was higher in the German case. On the islands, the rate of increase in jobs was below the national average in both countries. This may be because tourism is reaching its capacity on these mostly small islands, and there are few other economic opportunities. In Denmark as a whole, the number of jobs declined between 2002 and 2011, and this was also the case in the Danish Wadden area but to a lesser extent. Overall, in the German and Danish Wadden areas, the employment situation has outperformed the national level, whereas the growth in the Dutch sector has been below the national average.

Table 3 also shows the share of jobs in a selection of industries. Agriculture is responsible for around 6% of jobs in all three Wadden areas. In Dutch and Danish Wadden areas, the share of manufacturing employment is above the national average. Although the German Wadden area has a below national-average share of manufacturing jobs, the proportion in manufacturing is still much higher than in the neighbouring Dutch and German sectors. As would be expected, the proportion of tourist jobs is particularly high on the Wadden islands, especially on the German and Dutch islands. Jobs in education are below the national averages in all three Wadden areas, perhaps reflecting a reality where older children travel to the mainland for senior schools and higher-level education. This is particularly marked in the Dutch sector (both mainland and islands) and on the islands in the German sector. In general, the proportions working in the health sector reflect national rates although the figure for the Dutch islands is much lower. Roughly between 15 and 20% of the jobs are in healthcare, only in the Dutch Wadden area, and especially on the islands, is the share much lower.

With regard to the national employment rate, i.e. the number of jobs as a percentage of the working-age population, all three countries have reached the EU-Lisbon goal of 70%. This is also the case for the Wadden areas in Germany and Denmark, where the employment rates even exceed the national figures. However, this is in sharp contrast with the employment rate in the Dutch Wadden area, which at 58.1% in 2011 was more than ten percentage points below the EU-Lisbon goal, and nearly twenty percentage points below the national average. The fact that the employment rate is much lower in the Dutch Wadden than in its German and Danish counterparts, while the unemployment rates are not dissimilar, suggests a reality in which Dutch residents tend more often to travel further inland, beyond the Wadden area, for employment. This implies substantial commuting flows.

On the Wadden islands, the employment situation is, at least statistically, very good in the Netherlands and in Germany where it even exceeds 100%. This high employment rate is caused by jobs on the islands often being filled by workers living on the mainland or by workers who stay only temporarily on the island during the summer season but are not counted as inhabitants. In contrast, the employment rate on the Danish islands is much lower than in its neighbouring counterparts, and well below the national average. This may well be linked to the much smaller role that tourism plays on the Danish islands. Interestingly, despite the employment rate being much higher (and over 100%) on the German than on the Netherlands Wadden islands, the unemployment rate is also higher on the German islands. Further, the unemployment rate on the islands in all three countries is below the national average although in the wider Wadden areas unemployment rates are above the national averages in Germany and in the Netherlands.

Fig. 10 shows the employment situation at the more detailed spatial level of each Wadden municipality. It is apparent that most rural municipalities along the Dutch coast have low employment rates, probably because many people commute to the cities further inland for work. Broersma (2009) in fact calculated that almost half of all workers living in municipalities on the Dutch Wadden coast had jobs outside this area and were hence commuting. In Germany, there is a more scattered pattern, with municipalities with high employment rates next to municipalities with very low employment rates. Some small municipalities on the mainland, particularly in Schleswig–Holstein, will have inhabitants who fill a job in another, larger, municipality further away from the coast. Inherently, the smaller a municipality the more likely it is that residents will work elsewhere and, for the small German municipalities, the percentage that 'commute' probably exceeds the Dutch average. This helps explain the very low employment rates on the German Wadden coast. The Danish municipalities show a much more stable pattern of employment with rates between 60% and 80%, but this is largely due to the larger municipalities in Denmark. In effect, while people still travel to work in larger cities, in Denmark, with its larger municipalities, these cities may well fall within the same area as the place of residence.

**Table 3**
Labour market indicators, employment levels for 2011, growth between 2002 and 2011.

| | Jobs | Annual job growth | Employment rate | Unemployment rate | Percentage of jobs in 2011 in: | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | × 1000 | % | % | % | Agric. | Manuf. | Tourism | Educ. | Health |
| **Netherlands** | 8483.5 | 1.2 | 76.1 | 5.1 | 2.7 | 9.7 | 4.2 | 10.5 | 15.3 |
| Wadden area | 103.1 | 0.8 | 58.1 | 6.2 | 6.8 | 10.4 | 6.2 | 5.5 | 13.9 |
| Wadden islands | 12.8 | 0.6 | 86.9 | 3.9 | 7.7 | 4.1 | 25.7 | 4.8 | 7.3 |
| **Germany** | 39,000.0 | 0.5 | 72.3 | 5.4 | 4.7 | 22.6 | 3.1 | 3.8 | 12.8 |
| Wadden area | 341.9 | 0.7 | 79.5 | 7.1 | 5.8 | 18.2 | 7.8 | 3.0 | 14.1 |
| Wadden islands | 30.7 | 0.0 | 104.1 | 4.2 | 7.0 | 2.5 | 36.5 | 1.5 | 11.7 |
| **Denmark** | 2600.0 | −1.0 | 71.6 | 4.5 | 2.7 | 8.7 | 3.2 | 8.4 | 19.6 |
| Wadden area | 98.9 | −0.4 | 73.5 | 4.0 | 5.6 | 14.7 | 3.6 | 7.3 | 18.9 |
| Wadden islands | 1.0 | −0.7 | 53.5 | 3.5 | 1.3 | 2.1 | 11.0 | 8.8 | 17.1 |

Sources: LISA (Netherlands); national and regional German statistical agencies; Statistics Denmark.

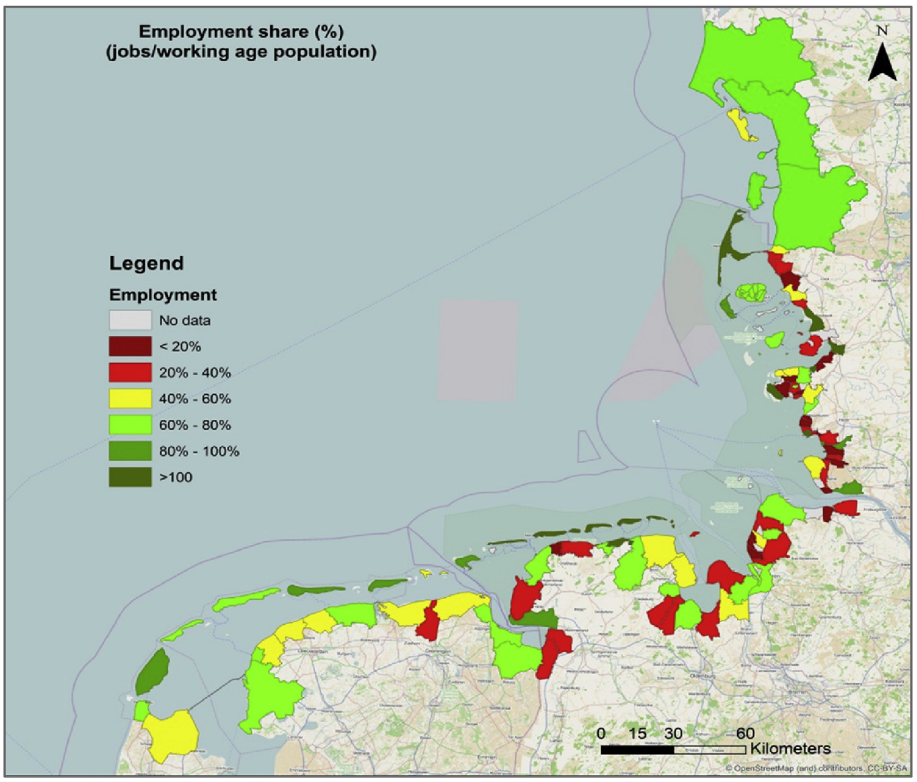


**Fig. 10.** Employment Rates (2011) for Wadden area by municipality.
Source: Eurostat.

### 5.2. *Jobs in the Wadden area at the detailed industry level*

We now turn to a more detailed analysis of the work opportunities within the Wadden area, i.e. within the municipalities bordering the Wadden Sea and on the Wadden islands. While the regional demarcation is the same in all three countries in terms of the governance level (i.e. municipalities), they differ in that Danish municipalities are LAU-1 aggregations whereas Dutch and German municipalities are aggregated on the LAU-2 level. This makes mutual comparison difficult. Another complicating factor is that municipalities in both Denmark and the Netherlands have been merged to form larger units in recent years. When we discuss figures for municipalities, we use the latest demarcation.

In analysing the breakdown of jobs by industry in the Wadden area we, as before, compare the area with national averages. This will highlight which industries are relatively dominant in the Wadden area (including the islands) relative to the rest of the country, and which industries are underrepresented. Fig. 11 shows the employment structure in 2011 for the three Wadden areas relative to the national structure. The first impression when looking at Fig. 11 is of an almost random pattern without any obvious overall message emerging. However, scrutinizing the data behind this figure reveals that the information broadly reflects the impression of the Wadden area so far obtained. First, the figure does show that, particularly in Denmark and the Netherlands, jobs in agriculture exceed the national average. In these two countries, this is also true for mining and extraction processes, and we will return to this later. Another eye-catching difference is that the German Wadden area has relatively few jobs in manufacturing whereas, in Denmark, there is an above-average proportion of manufacturing jobs. Again, the relative sizes of municipalities in the two countries are likely to play a part.

Fig. 11 further shows that the proportions of jobs in commercial and non-commercial services (the top part of the figure down to 'Trade') are generally, with a few notable exceptions, all below national averages. One exception is in Transport where, in both Germany and the Netherlands, an above average proportion of residents in the Wadden area have jobs in the transport sector. This is very likely a result of jobs related to the ferries to and from the islands. Second, there is a pronounced larger proportion of jobs in the accommodation industry. This is particularly the case in the Dutch and German Wadden areas and largely a result of the large tourist industry on the islands. In fact, on the Dutch and German Wadden islands, 1 in every 3 to 5 jobs has been linked to tourism. Tourism is less important on the Danish islands where it only accounts for 1 in 10 jobs. The trends are also different, with tourism growing and providing more employment on the German and Dutch islands but diminishing in the Danish part over the past ten years.

Perhaps the most eye-catching point highlighted by Fig. 11 is the well-above average proportion of public sector jobs in the Dutch and German Wadden areas. This is due to the large number of defence personnel based at naval bases along the Wadden coast. The Dutch naval base is in Den Helder, while Germany has a naval base in Wilhelmshaven and navy-related activities in Bremerhaven and Nordholz. If these naval jobs were excluded, employment in the public sector in the Dutch and German areas would be close to the national averages. Another interesting observation is that the Dutch Wadden area has disproportionally few jobs in education compared to the German and Danish Wadden areas, a point also apparent in Table 3. Many municipalities in the Dutch Wadden area have a low and falling number of inhabitants and so can support few secondary and tertiary institutions of education. Such institutions, and the associated jobs, are concentrated in larger

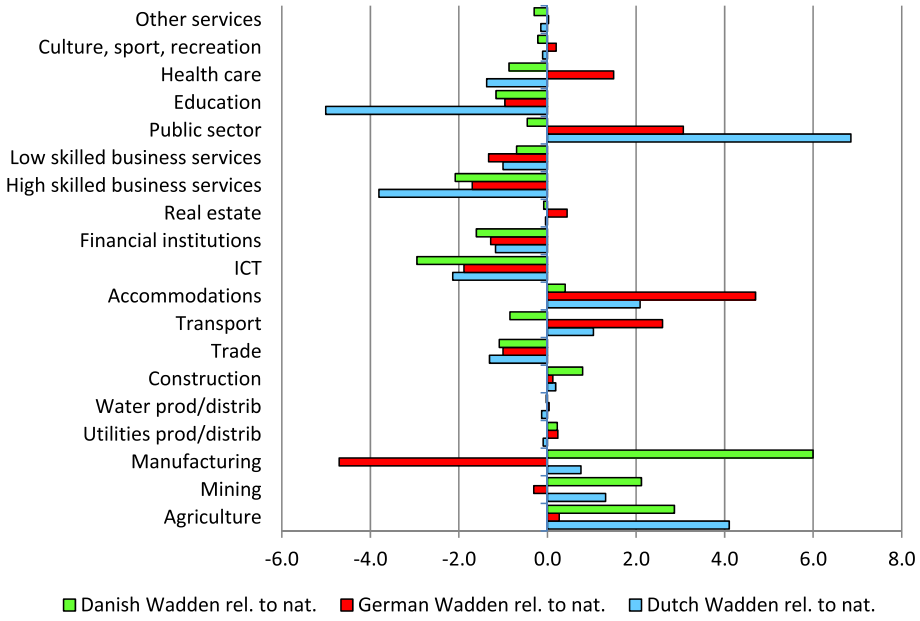


**Fig. 11.** Employment structure of jobs in Wadden area relative to national structure, 2011.
Source: LISA (Netherlands); national and regional German statistical agencies; Statistics Denmark.

municipalities further from the coast. In Germany, the pattern of schools is less concentrated than in the Netherlands, so the size of a municipality is less of a factor. Given that the Danish employment data are for the larger LAU-1 areas, any differences tend to be smoothed out.

### 5.3. Productivity in the wider Wadden area

A problem associated with the population continuing to contract and age in the Wadden area is that firms and institutions will eventually leave the Wadden area and move inland. In other words, the population shrinkage will negatively affect the economic activities in the area. First, firms in the basic sector, i.e. industries whose performance primarily depends on economic activities external to the local economy, will contract or and move towards larger cities (McCann, 2013). Eventually, if the population continues to shrink, even the non-basic sector and local activities, such as local shops, schools and healthcare facilities, are likely to close down or move to larger cities inland. In other words, the liveability of the smaller Wadden municipalities is likely to deteriorate.

When firms close down or move away, the municipalities become poorer with shrinking GDPs (Gross Domestic Product). Unfortunately, GDP is not measured at the municipality level but at the higher NUTS-3 level. Therefore, when we look at GDP figures to assess the local economy, we are forced to include a much larger area than in the previous analysis. This can be seen by comparing the areas highlighted in Fig. 2 (NUTS-3) and 3 (LAU-2). Despite this broadening of the area, we believe it is still worthwhile to compare changes in the regional labour productivity for the NUTS-3 areas bordering the Wadden Sea in our three countries relative to national GDP figures. This will give an indication of the regional competitiveness of these Wadden NUTS-3 areas, and this must reflect the municipalities within them and thus provide an indication of the competitiveness of the Wadden municipalities.

We look at the growth rates in regional labour productivity, namely the GDP per hour worked, of the NUTS-3 Wadden regions relative to national labour productivity growth rates. Assuming that regional and national price deflators are the same, the differences between regional and national productivity growth will be in constant prices. Fig. 12 presents the average annual (between 2007 and 2010) rates of labour productivity growth, relative to the national figures, for the NUTS-3 regions bordering on the Wadden Sea.

Generally, the Wadden regions saw below national-average productivity growths, that is productivity grew less than in the respective country as a whole. All four Dutch and the one Danish Wadden NUT-3 regions have productivity growth rates below the national average. In Germany, the situation is more nuanced, with two Wadden regions (Emden and Wesermarsch) enjoying well-above average productivity growths. Emden not only includes an important harbour, it also has an important automobile industry (VW); while Wesermarsch has an important aircraft industry (Premium AEROTEC, which produces Airbus components). These activities are associated with high levels of innovation and automation, and require relatively highly educated workers. This can explain why productivity growth in these two regions exceeds the national average. The other German Wadden regions have productivity growth rates close to or below the national average.

This relative regional labour productivity growth figures give an indication of regional competitiveness compared to the country-wide position. Since productivity growth is related to issues such as schooling, capital intensity and innovation, the negative relative growth figures suggest that the Wadden area as a whole is likely to be lagging behind in terms of these other indicators. So, in general terms, the Wadden area in all three countries is likely to be lagging in terms of competitiveness, skills and innovation.

## 6. What is left for the Wadden area?

The adoption of ICZM as defined by the WSF aims to ensure that the ecosystem and the social system can both develop in a sustainable way. Humans use the area and consequently put pressure on the ecosystem that leads to all sorts of effects. Due to this, the system needs to be managed such that both the ecosystem and the social system can develop in a sustainable way. The crucial question is how to balance economic and ecological goals. An important question in this respect is whether there are enough jobs for the

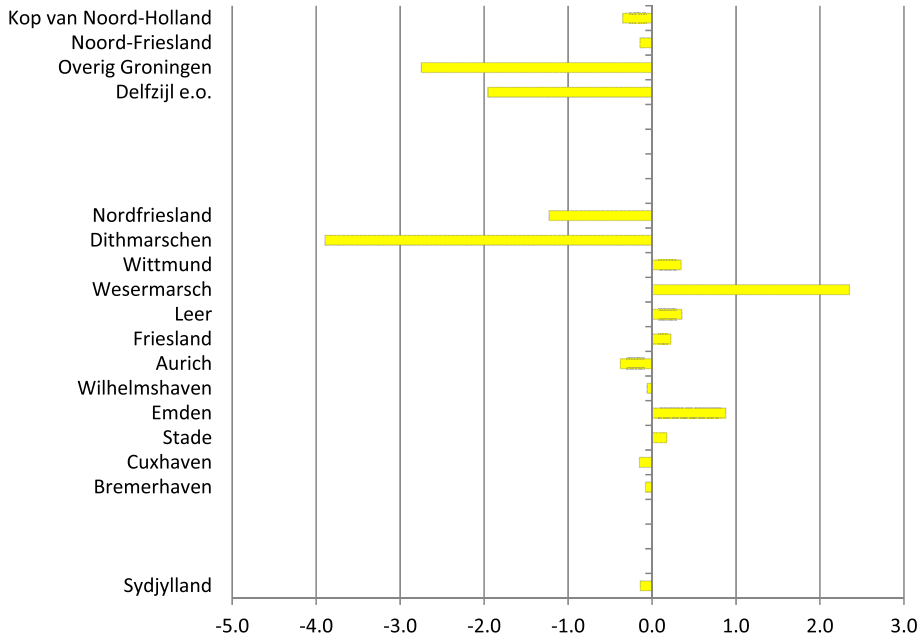


**Fig. 12.** Average annual percentage productivity growth between 2007 and 2010 in the NUTS-3 Wadden regions relative to national productivity growth. Source: calculated from Eurostat data and EUKLEMS data (www.euklems.net).

inhabitants in the Wadden area. A relevant indicator here is the so-called employment rate, i.e. the number of jobs available for the population in the 15–64 age group. The European Union set a target of this rate being at least 70% by 2010. Nationally, all three countries meet this target. The German and Danish Wadden areas have employment rates below their national averages but still above the EU target. However, in the Dutch Wadden area, the rate is substantially lower at 58%. However, we should not overlook the fact that the analysis leading to these figures is based on the spatial unit of the municipality and that these are generally much smaller than a regional labour market. One definition of a regional labour market is that of the spatial area that can be covered with a maximum commuting time of 90 min per day. For most inhabitants of the Dutch coastal municipalities, jobs outside their own municipality and in the nearby major cities of Leeuwarden and Groningen would fit within this definition. With employment available in such nearby locations, the relatively low employment rates in our narrow definition of the Wadden area does not imply the ICZM is failing in its goal of providing jobs and income for the inhabitants of the Wadden area.

This does not mean that further job creation within the coastal municipalities is undesirable. People generally prefer shorter commuting times, and economic activities in an area are also good for social cohesion, through such activities as sponsoring local sports teams and other activities, and may encourage people of working age to remain in an area rather than move elsewhere. Outmigration is a noticeable phenomenon, particularly at the Dutch Wadden islands, where households with children and single youngsters tend to leave when they reach secondary school age, as these schools are only present in the larger residential areas. Adults also often want to live in places where they are close to where they work and where there are more and a broader range of employment opportunities and this draws them to the larger cities and surrounding villages within a range of about 20 km. This is evident from the population growth currently taking place in the larger residential areas further away from the Wadden coast and closer to the larger cities. At the same time, firms and institutions are also tending to leave the Wadden area so, overall, economic activities seem to be in decline. As such, there is a need to create jobs in these areas. However, given the goals of ICZM, any economic activities stimulated should not be harmful for the ecosystem. Large-scale industrial activities, such as chemical plants, gas and salt extraction and coal-fired power plants, pose potential risks and should therefore be avoided. This should not be a major limitation since, as a general rule, 90% of economic activities pose hardly any direct risk to the environment (Van Dijk et al., 2011). Today, something like 75% of the economy is related to jobs in the service sector. Here there is a concern since most firms in this sector prefer a more urban environment to the rural environment of the coastal municipalities. Our analysis has also shown that, in terms of labour productivity, the competitive power of the Wadden area is limited. However, one should not ignore the fact that some people prefer to live in quieter rural areas with relatively inexpensive large houses on large plots of land and clean air (Bijker, 2013). Their expenditure in local shops and consumption of public facilities may help maintain the level of services in the Wadden area. For ICZM, this raises the question as to which types of economic activities can generate jobs in the coastal municipalities because of certain locational advantages without harming the ecosystem.

First, there are people who live, or would like to live in the Wadden area, who are employed in economic activities that are footloose in terms of locational preferences: designers, journalists, scientists, writers and artists can do their work anywhere. A recent investigation by the Waddenvereniging (2013) showed that a substantial number of small innovative firms are located in the Dutch coastal zone. This innovativeness need not only relate to technical innovations, but also to social and market innovations such as internet shops and wellness facilities. Such small firms get much less attention in the media than the traditional economic sectors, but they are still important for a vital regional economy in the coastal zone. The motivation for these small innovative firms to locate in the Wadden area is that they want to work in the unique natural environment that is provided in the Wadden area. As such, the locational advantages for these footloose firms are not related to the type of economic activity but to the residential preferences of the owners and workers.

There are also economic activities that are likely to stay in the Wadden area because of the locational advantages it offers related

to the type of business: (i) agriculture and fishing, (ii) extraction of energy (oil, gas, wind), (iii) harbours and (iv) tourism; and, with these, related personal and business services. Agriculture is particularly located in the mainland coastal area. Broersma (2009) showed that the number of large (over 50 ha) agricultural firms had increased over the past fifteen years at the expense of smaller ones. As such, the Wadden area can be characterized by substantial upscaling of its agricultural firms. One aspect of this, in the case of dairy farming, is industrial scale production with herds of over a thousand cows (the so-called mega-stables). This may be harmful for the Wadden area as these farms require more transport movements regarding animal feed, livestock and milk, which may harm the area and make the landscape less attractive. Seed potatoes have been a major export product of the Dutch Wadden area and this product is tied to the Wadden region because of the need for fresh air and a windy environment to minimize the risk of diseases spreading through a crop. Potentially prosperous avenues for further developments in agriculture might be to invest in developing salt-tolerant potatoes and other crops that will grow in a salt environment. The Wadden coast is an ideal area for experiments and the production of salt-tolerant crops and this can be incorporated in innovation-oriented ICZM.

Fishing activities are also directly linked to the location of the Wadden Sea and these have traditionally concerned the harvesting of cockles, mussels and shrimps. The mechanical removal of cockles was particularly harmful to the seabed in the Wadden Sea and this has now been banned (Piersma et al., 2001). Similarly, fishing for mussel seed in the Wadden Sea was also considered as very harmful for the seabed, but this type of fishing is now moving towards other, less harmful, ways of cultivating mussels (Puente-Rodríguez et al., 2015b). Shrimp fishing is still a problem and faces the risk of being limited due to the damage it causes to the ecosystem (Ramsay et al., 1998; Temming and Hufnagel, 2015). One possibility is to reduce the number of shrimps brought to the market, but to boost the value added in the region. This requires the value chain to become more localized in order to generate more jobs in the area. Today, shrimps are transported to Morocco for peeling because the low transport costs and the low labour costs there make this attractive. However, the quality of the shrimps is much lower than if they were freshly peeled in the Wadden area. New innovative mechanical peeling machines make it viable to return this part of the value chain to the region, and the region can further benefit if fresh high-quality shrimp products can be sold at higher prices to consumer at the regional market.

Mining, in terms of the extraction of natural gas, oil and salt, and lately energy from the wind, is also important in the Wadden area. In the Dutch part of the Wadden Sea itself, there is one rig to extract natural gas ('Zuidwal, west of the harbour of Harlingen) and, in the German part, one to extract oil ('Mittelplatte' at the bend between Niedersachsen and Schleswig–Holstein). In the mainland coastal region, natural gas is extracted only in the Dutch part, with several extraction points in the large 'Slochteren' gas field. This extraction is now being heavily debated following several, increasingly more frequent and also heavier, earth tremors which have had a significant negative effect on the housing market and the perceived quality of life (Van der Voort and Vanclay, 2015). Further, at some locations, gas is extracted from under the sea from onshore drillings.[5] Ameland, one of the Dutch Wadden islands, also contains a drilling rig for gas. In addition to natural gas extraction, the Dutch Wadden area will become part of the so-called 'gas roundabout', where Russian natural gas deliveries will be stored for later delivery throughout north-west Europe. The projected liquid natural gas (LNG) storage units at Eemshaven on the Dutch Wadden coast is also part of this roundabout. It is unclear if these activities will increase the risk of tremors and how they might affect the ecosystem. Unlike in the Dutch sector, there is no significant extraction of natural gas or oil along the German and Danish Wadden coasts. Instead, there are large numbers of wind turbines used to extract energy from the wind.[6] Solar energy is a growing, but still relatively expensive, alternative to traditional sources of energy and energy from wind. Germany is the world's frontrunner in terms of solar energy. When they abandoned their use of nuclear energy plants, they adopted solar energy in a large way but need to provide large subsidies for it to be financially attractive to investors and energy suppliers. All types of energy production have potentially negative effects for the Wadden region. These range from the direct polluting effects linked to extraction, indirect effects such as soil subsidence and earthquakes, the effects of dredging to allow cheap fuel transport, and the noise and visual pollution from wind turbines. There is also some non-energy mining in the Wadden area, including the extraction of seasalt, sand and shells. The salt mining activities near Harlingen are now under debate because the salt is under the Wadden Sea and this may lead to soil subsidence that may have negative consequences for migratory birds.

Harbour activities also offer locational advantages to the Wadden area. Harbour activities help the economic development of the municipality in which they are situated, most obviously because people work directly in the harbour or in the supply and consuming industries. However, harbours are potentially harmful to the environment, particularly here to the vulnerable Wadden Sea. The approach routes to and from the ports cross the Wadden Sea need regular dredging in order to receive the large ships.[7] Another environmental risk is that ships lose containers or other goods that are dangerous for the ecosystem.

Finally, in terms of key economic activities, tourist-related activities are also linked to the unique assets of the Wadden area. On the islands themselves, most of the tourist activities are located on or near to the North Sea beaches rather than on the Wadden Sea. Nevertheless, the islands carry the burden of an increasing number of tourists with impacts on land-use, pollution, the local population and so on. On the German island of Sylt, for instance, the inflow of rich and famous people caused an enormous increase in housing prices with as a result that most natives are forced to live on the mainland and commute back to the island for work every day. Tourists and all the associated supplies need to cross the Wadden Sea to the islands, which again requires navigable channels that involves regular dredging and thus potentially harmful activities to the Wadden Sea. On the mainland coast, there are substantial tourism activities in the German part of the Wadden area, but not in the Dutch or Danish parts. As such, there is still a potential for further tourism development within the limits set in the adopted joint strategy for "Sustainable Tourism in the Wadden Sea World Heritage Destination" (CWSS, 2014). This strategy has been developed at the request of the World Heritage Committee through a participatory approach. As part of this, a solid transnational network of stakeholders has been established over the last two years that will be continued and provide the framework for the implementation of the joint strategy. This may lead to the creation

[5] This is known as 'titled drilling', where drilling takes place on the shore to extract gas from below the seabed.

[6] There are also plans for large-scale 'windfarms' in the North Sea, but outside the Wadden area.

[7] This is also true for harbours further inland that are approached through the Wadden Sea. A noteworthy example is the port of Papenburg, where the Meyer wharf builds enormous cruise ships that have to pass through the River Ems to get to the Wadden Sea. This involves dredging activities that are harmful for the Wadden Sea and especially in the estuaries like e.g. the Ems-Dollard.

of new jobs with skill levels that fit the characteristics of the inhabitants of the Wadden area.

Besides the above activities, other types of personal and business services can possibly be attracted to the Wadden area. Many economic activities are increasingly footloose with the advent of the internet and high-speed broadband access, and this makes it easier for those who want to live and work in the unique natural environment of the Wadden region to do so. Footloose firms that want to move to the Wadden area can relatively easily find locations with empty properties such as farmhouses and churches ripe for adaption. Here, access to a good fast broadband internet is essential but many activities do not need frequent face-to-face contact with suppliers, consumers and similar firms.

For ICZM in the broader sense, as defined by the WSF, it is important to note that all the above-mentioned existing economic activities gain locational advantages from being in the coastal area and are therefore unlikely to completely disappear from the Wadden area. The challenge is to minimize the risks to the ecosystem while creating sufficient non-harmful economic activities to secure a vital regional economy in the coastal zones. This implies that large-scale industrial activities, and energy production with potential harmful effects, should be discouraged. Especially when alternative locations outside the Wadden area are available to realize the same production, even though the production costs may be higher at alternative locations, the overall negative effects on the population can be fairly small and so these alternative sites should be actively considered. Another negative effect, specific to the Wadden region itself, might be that jobs disappear or are not created. However, this is the price that maybe has to be paid to secure the unique natural values of the Wadden Sea. A vital regional economy in the coastal municipalities could also be created based on economic activities that are not harmful to the ecosystem. In addition, sufficient employment could be created away from the immediate coast but within comfortable commuting distance. For ICZM in the broader sense, this implies that it is no longer appropriate to use the Ketchum (1972) definition of the coastal zone area - the band of dry land and adjacent sea space (water and submerged land) in which terrestrial processes and land uses directly affect ecosystem processes and uses, and *vice versa* - but to consider economic relationships over a much wider area. That is, for ICZM, the required spatial scale is much larger than the previously defined 'narrow band'.

## 7. Concluding remarks

ICZM, as defined by the WSF (2013), aims to manage the Wadden area such that both the ecosystem and the social system can develop sustainably. In this study, socioeconomic and demographic characteristics of the Wadden area are discussed on a very detailed geographical scale in order to gain insights into the economic and demographic developments of the area located very close to the Wadden Sea, where the role and influence of the Wadden Sea itself can still be felt. This involved considering only the first line of municipalities that actually border on the Wadden Sea. Using a broader definition would mean that some activities deemed to be in the Wadden area might have only a very weak link at best to the Wadden Sea itself. Under our narrow definition of the coastal zone, with the small spatial scale of the municipality as the unit of analysis, we found that the Wadden area is seeing a declining population in all three countries. Moreover, the population is ageing, and the share of young people is declining such that the potential labour force is shrinking. This is the general picture, but there are differences between the countries, and between the islands and the coastal mainland. For instance, the ageing problem has grown much more rapidly in the Dutch Wadden area in the last decade than in the other two countries, as has the decline in the share of the population of working age. Although the percentages of the population of working age in both Germany and Denmark have remained steady, the proportion in this age group is much lower in the Danish part than in the German part. In effect, the Dutch part has seen the proportion drop from the German to the Danish level in the last ten years. Unemployment rates are substantially above the national averages in the Dutch and German Wadden coastal areas, but lower in the Danish part and on the islands. We also found substantial differences between neighbouring municipalities within the coastal areas. Although most municipalities are seeing a population decline, there are some areas where the population is increasing.

Sustainably developing both the ecosystem and the social system, as targeted by the WSF, requires an understanding of the regional economic structure of the trilateral Wadden area and acknowledging that it is very diverse and differs substantially from the national economic structures. However, even within the Wadden area, there are substantial economic differences. Some estuaries are home to intensive harbour activities with industrial sites with large-scale production of chemical products, gas and salt extraction facilities and power plants that require the import and further transportation of coal. These activities are potentially the most dangerous for the Wadden ecosystem and for its unique natural values. This nature forms the assets that led to the Wadden area being classified as UNESCO World Heritage and is the basis for the tourist industries that, especially for many of the islands, are the dominant economic activity. The estuaries where these industrial activities take place are excluded from the area defined as the UNESCO World Heritage site. With large-scale industrial activities at odds with World Heritage Status, there are tensions when addressing the need to provide the inhabitants of the Wadden area with jobs, adequate incomes, good living conditions and a long life expectancy. Social equality and a satisfactory work-life balance should be achievable by Wadden residents as much as by those elsewhere. This requires ICZM to aim for balanced economic development that provides prospects for people living and working in the Wadden area, but that also generates surpluses for environmental protection measures to preserve the unique natural values of the Wadden area since these are a major asset in creating jobs in tourism, and also provide clean air and a healthy living environment.

As such, ICZM should include encouraging and enabling economic developments involving activities that are footloose in terms of location choice, that do not have a negative effect on the ecosystem, that are at an economic and spatial scale that fits with the natural environment and that reflect the skills and jobs of the inhabitants. Our analysis shows that, within sectors such as agriculture, fishing, tourism and personal and business services, there are many activities that fit within these constraints and would enable a vital regional economy to continue in the coastal zone. In addition, jobs could be created outside the coastal zone but within a reasonable commuting distance. Large-scale industrial activities should be discouraged in the Wadden area and, if unavoidable, only be allowed in the present industrial zones provided any potential damage to the ecosystem is manageable. Based on these pressures and the management challenges inherent to a broader ICZM approach, insights are needed into the combined ecological and socioeconomic system of the whole Wadden Sea in order to design science-based monitoring and management support systems. The essential characteristics of this approach are strongly interdisciplinary and require an ICZM focus on aspects of scale and cumulative processes to keep track of the impacts of autonomous processes and human activities on the unique natural values of the Wadden UNESCO World Heritage Site.

## References


Adviesgroep Waddenzeebeleid, 2004. Ruimte voor de Wadden – Eindrapport Adviesgroep Waddenzeebeleid. 's-Gravenhage: VROM en EZ, p. 63.

Arndt, O., Dirks, H., Koch, T., 2004. The Wadden Sea Region: a Socio-Economic Analysis. Prognos AG, Bremen.

Bazelmans, J., Meier, D., Nieuwhof, A., Spek, T., Vos, P., 2012. Understanding the cultural historical value of the Wadden Sea region. The co-evolution of environment and society in the Wadden Sea area in the Holocene up until early modern times (11,700 BC – 1800 AD): an outline. Ocean Coast. Manag. 68, 114–126.

Broersma, L., 2009. Developments in Main Socio-Economic Sectors of the Wadden area' (in Dutch: 'Ontwikkelingen in de belangrijkste sociaal-economische sectoren van het Waddengebied'), appendix in, Raad voor de Wadden, Visie en focus Waddenfonds, background report of advice 2009/3 of the Raad voor de Wadden, pp. 50–64 (all in Dutch). http://www.raadvoordewadden.nl/fileadmin/inhoud/pdf/adviezen_ned/2009/200903_achtergrondrapport_advies_wf.pdf.

Broersma, L., van Dijk, J., 2002. Regional labour market dynamics in The Netherlands. Pap. Regional Sci. 81 (3), 343–364. http://dx.doi.org/10.1111/j.1435-5597.2002.tb01238.x.

Bijker, R., 2013. Migration to Less Popular Rural Areas: the Characteristics, Motivations and Search Process of Migrants (PhD thesis) University of Groningen. Shaker Publishers, Maastricht.

CPSL, 2010. CPSL Third Report, the Role of Spatial Planning and Sediment in Coastal Risk Management, Wadden Sea Ecosystem No. 28. Common Wadden Sea Secretariat. Trilateral Working Group on Coastal Protection and Sea Level Rise (CPSL), Wilhelmshaven, Germany.

CWSS, 1998. Stade Declaration. Trilateral Wadden Sea Plan. Common Wadden Sea Secretariat, Wilhelmshaven.

CWSS, 2008. The Wadden Sea Waddenzee – Wattenmeer – Nomination of the Dutch-German Wadden Sea as World Heritage Site. Common Wadden Sea Secretariat (CWSS), Wilhelmshaven.

CWSS, 2012. The Wadden Sea, Germany and Netherlands (N1314) – Extension Denmark and Germany. Common Wadden Sea Secretariat (CWSS), Wilhelmshaven.

CWSS, 2014. Sustainable Tourism in the Wadden Sea World Heritage Destination. Common Wadden Sea Secretariat (CWSS), Wilhelmshaven.

De Beaufort, L.F., 1954. Veranderingen in de flora en fauna der Zuiderzee (thans IJsselmeer) na de afsluiting in 1932, De Boer, Den Helder (in Dutch).

De Jong, F., 2011. ICZM and the Wadden Sea: management across boundaries. In: Wolanski, E., McLusky, D. (Eds.), Treatise on Estuarine and Coastal Science. Academic Press, Waltham, pp. 159–178. http://dx.doi.org/10.1016/B978-0-12-374711-2.01110-4.

De Jonge, V.N., Essink, K., Boddeke, R., 1993. The Dutch Wadden Sea: a changed ecosystem. Hydrobiologica 265, 45–71.

De Jonge, V.N., Pinto, R., Turner, R.K., 2012. Integrating ecological, economic and social aspects to generate useful management information under the EU Directives 'ecosystem approach. Ocean Coast. Manag. 68, 169–188.

Delfmann, H., Koster, S., McCann, Ph, van Dijk, J., 2014. Population change and new firm formation in urban and rural regions. Reg. Stud. 48 (6), 1034–1050. http://dx.doi.org/10.1080/00343404.2013.867430.

Enemark, J., 2005. The Wadden Sea protection and management scheme – towards an integrated coastal management approach? Ocean Coast. Manag. 48, 996–1015. http://dx.doi.org/10.1016/j.ocecoaman.2005.03.009.

Fischer, L., 2011. Küste – Von der Realität eines mentalen Konzepts. In: Fischer, L., Reise, K. (Eds.), Küstenmentalität und Klimawandel. Oekom, München, pp. 31–53 (in German).

Giebels, D., van Buuren, A., Edelenbos, J., 2013. Ecosystem-based management in the Wadden Sea: principles for the governance of knowledge. J. Sea Res. 82, 176–187. http://dx.doi.org/10.1016/j.seares.2012.11.002.

Kabat, P., Bazelmans, J., van Dijk, J., Herman, P.M., van Oijen, T., Pejrup, M., Reise, K., Speelman, H., Wolff, W.J., 2012. The Wadden Sea Region: towards a science for sustainable development. Ocean Coast. Manag. 68, 4–17. http://dx.doi.org/10.1016/j.ocecoaman.2012.05.022.

Ketchum, B.H., 1972. The water's edge: critical problems of the coastal zone. In: Coastal Zone Workshop, 22 May-3 June 1972 Woods Hole. MIT Press, Massachusetts. Cambridge.

Knottnerus, O.S., 2005. History of human settlement, cultural change and interference 1048 with the marine environment. Helgol. Mar. Res. 59, 2–8.

McCann, P., 2013. Modern Urban and Regional Economics. Oxford University Press, Oxford.

Oosterhaven, J., 1981. Interregional Input-Output Analysis and Dutch Regional Policy Problems. Gower Publishing, Aldershot-Hampshire.

Piersma, T., Koolhaas, A., Dekinga, A., Beukema, J.J., Dekker, R., Essink, K., 2001. Long-term indirect effects of mechanical cockle-dredging on intertidal bivalve stocks in the Wadden Sea. J. Appl. Ecol. 38 (5), 976–990.

Puente-Rodríguez, D., Giebels, D., de Jonge, V.N., 2015a. Strengthening coastal zone management in the Wadden Sea by applying 'knowledge-practice interfaces. Ocean Coast. Manag. 108, 27–38.

Puente-Rodríguez, D., Swart, J.A.A., Middag, M., Van der Windt, H.J., 2015b. Identities, communities, and practices in the transition towards Sustainable Mussel Fishery in the Dutch Wadden Sea. Hum. Ecol. 43 (1), 93–104.

Ramsay, K., Kaiser, M.J., Hughes, R.N., 1998. Responses of benthic scavengers to fishing disturbance by towed gears in different habitats. J. Exp. Mar. Biol. Ecol. 224 (1), 73–89.

Reise, K., 2005. Coast of change: habitat loss and transformations in the Wadden Sea. Helgol. Mar. Res. 59, 9–21.

Reise, K., 2011. Das Wattenmeer – Wirklichkeiten und Visionen. In: Fischer, L., Reise, K. (Eds.), Küstenmentalität und Klimawandel. Oekom, München, pp. 167–179.

Reise, K., Baptist, M., Burbridge, P., Dankers, N., Fischer, L., Flemming, B., Oost, A.P., Smit, C., 2010. The Wadden Sea – a universally outstanding tidal wetland. Wadden Sea Ecosystem No. 29. Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

Reise, K., 2013. A Natural History of the Wadden Sea – Riddled by Contingencies. Wadden Academy/CWSS, Leeuwarden/Wilhemshaven.

Runhaar, H., Runhaar, P.R., Oegema, T., 2009. Food for thought: conditions for discourse reflection in the light of environmental assessment. Environ. Impact Asses Rev.

Sijtsma, F.J., Werner, G.J., Broersma, L., 2008. Recreatie en toerisme in het Waddengebied – Toekomstige ontwikkelingsmogelijkheden en hun effecten op economie, duurzaamheid en identiteit. Analyserapport behordende bij advies 2008/05. Raad voor de Wadden, Leeuwarden.

Sijtsma, F.J., Daams, M.N., Farjon, H., Buijs, A.E., 2012. Deep feelings around a shallow coast. A spatial analysis of tourism jobs and the attractivity of nature in the Dutch Wadden area. Ocean Coast. Manag. 68, 128–138.

Temming, A., Hufnagel, M., 2015. Decreasing predation levels and increasing landings challenge the paradigm of non-management of North Sea brown shrimp (Crangon crangon). ICES J. Mar. Sci. 72 (3), 804–823.

Van der Voort, N., Vanclay, F., 2015. Social impacts of earthquakes caused by gas extraction in the Province of Groningen, The Netherlands. Environ. Impact Assess. Rev. 50, 1–15. http://dx.doi.org/10.1016/j.eiar.2014.08.008.

Van Dijk, J. van, Sijtsma, F.J., Folmer, H., 2011. Het Waddengebied als leefruimte. Econ. Statistische Berichten Dossier Land Zicht – Dialoog tussen Econ. en natuur 96 (4612S), 45–50, 10 juni 2011.

Van Leeuwe, M., Haartsen, T., 2012. Dynamics as key value of the Wadden Sea Region. Ocean Coast. Manag. 68, 1–3.

Vollmer, M., Guldberg, M., Maluck, M., Marrewijk, D., Schlicksbier, G., 2001. Landscape and Cultural Heritage in the Wadden Sea Region. Project Report, Wadden Sea Ecosystem No. 12. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany.

Waddenvereniging, 2013. Werelderfgoed Waddenzee Biedt Kansen – Een Rapport Op Basis Van Gesprekken Met Ondernemers in Het Waddengebied. Waddenvereniging, Harlingen, p. 1.

Waddenzeecommissie, 1974. Rapport van de Waddenzeecommissie. Rijkswaterstaat, s-Gravenhage, p. 328.

WSF, 2010. Without Frontiers – Achievements in Cross-border, Cross-sector, Communication and Cooperation. Wadden Sea Forum (WSF), Wilhelmshaven.

WSF, 2013. ICZM Strategy for the Wadden Sea Region. Wadden Sea Forum (WSF), Wilhelmshaven.

Wolff, W.J., 1976. Introduction to the subject and goal of the conference of Wadden Sea experts. Staatsuitgeverij, 's Gravenhage. In: Wolff, W.J. (Ed.), Proceedings of the Conference of Wadden Sea Experts, Schiermonnikoog, The Netherlands, 26/28 November 1975, p. 29e33.

Wolff, W.J., 1992. The end of a tradition: 1000 years of reclamation of wetlands in The Netherlands come to an end. Ambio 21, 287–291.

Wolff, W.J., 2013. Ecology of the Wadden Sea: research in the past and challenges for the future. J. Sea Res. 82, 3–9.